MAIZE GENETICS COOPERATION

NEWS LETTER

9

March 6, 1935

Department of Plant Breeding
Cornell University
Ithaca, N. Y.

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MAIZE GENETICS COÖPERATION
DEPARTMENT OF PLANT BREEDING
CORNELL UNIVERSITY
ITHACA, NEW YORK

January 21, 1935

To Maize Geneticists :-

This letter is a call for lists of new genetic stocks, news items, etc., for another corn letter which will be issued around the first of March. Please go over your genetic testers and list any new combinations you have developed. Also send a small sample of each stock to this laboratory and we will increase it for general distribution. News items are, of course, always welcome additions. The dead line for receipt of this material is February 15. Your cooperation is not only desired, it is essential.

Sincerely yours,

(signed) M. M. Rhoades

MMR:B

M. M. Rhoades

Letter sent to: E. G. Anderson, Beadle, Brink, Brunson, Burnham, Clokey, Collins, Eyster, Hayes, Jenkins, Jones, Kempton, Lindstrom, Mangelsdorf, Perry, Singleton, Sprague, and Stadler.

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MAIZE GENETICS COÖPERATION
DEPARTMENT OF PLANT BREEDING
CORNELL UNIVERSITY
ITHACA, NEW YORK

Vol. 9 March 6, 1935

To Maize Geneticists :-

This maize letter contains a list of new genetic stocks, as well as a considerable number of news items. Several new stocks were listed in the last maize letter - they will not be repeated here. The response of the various investigators to the request for material has, as heretofore, been gratifying and has made possible this series of maize letters.

The new stocks have been grouped together as follows:

From Singleton

Chromosome 4 stocks:

1. $\frac{+\ su\ Tu}{wl\ +\ +}$ x wl su tu.
2. $\frac{Ts_5\ +\ su}{+\ wl\ +}$ x ts wl su.
3. $\frac{su\ +}{+\ sp}$.
4. $\frac{su\ sp}{+\ +}$.
5. $\frac{su\ lo}{+\ +}$.
6. $\frac{su\ +}{+\ lo}$.
7. su Ts_5.
8. $\frac{wl\ su\ +}{+\ su\ gl_3}$ F_2.
9. $\frac{Ts_5\ +\ su}{+\ wl\ su}$ F_2.
10. $\frac{wl\ +\ tu}{wl\ su\ tu}$ x wl su Tu.

Stocks other than chromosome 4:

Chromosome 1. P ts_2 f_1 bm_2.

Chromosome 2. v_4 $\frac{ts_1}{+}$ gl_2 lg_1 and lg_1 gl_2 v_4 A C r^g Y Su.

Chromosome 5. v_2 bm_1 pr.

Chromosome 7. gl_1 v_5 seg. ra_1 and gl_1 ij Y Su.

From Burnham

Chromosome 1. f_1 an bm_2.

Chromosome 1. P f_1 bm_2 and p f_1 bm_2.

Chromosome 2. lg_1 gl_2 b v_4 which does not carry Pl or r^g, it is probably r^r.

From Randolph

10-chromosome tester stocks:

1. A_1-na-cr C R^g pr in su y-pl b-lg_1 j bm_2.
2. A_1-Na na (Cr cr)? C R^g pr in su y-pl j b-lg_1 bm_2- $\frac{ts_2}{Ts_2\ ts_2}$.
3. A_1 c R^g-g_1 pr In-Bn su y-pl b-lg j bm_2.
4. A_1-cr c R^g-G_1g_1 pr In (in)? - Bn Su su y-pl b-lg_1 j bm_2.
5. A_1-D (d)? c R^g-g_1 pr In (in)? - Bn Su Su and Su su y-pl b-lg_1 j bm_2 - Ts_2 ts_2.
6. A_1-D (d)? c R^g-g_1 pr In-Bn su y-pl b-lg j bm_2 P^{VV}.

From Jenkins

Chromosome 5:

1. A_1 C R A_2a_2-bt_1-bv-pr.
2. A_1 A_2 C R bt_1-bv-pr.
3. A_1 C R a_2-bt_1-bv-pr.
4. A_1 A_2 C R bv-pr-v_2.
5. A_1 A_2 C R bt_1-bv-pr.

Jenkins will have pollen this summer from:

a_2-bt_1-bv-pr-v_2 plants.

Chromosome 4:

1. la-su-Tu tu-gl_3.
2. la-su-tu-gl_3.

News items from Ithaca

1. Order is su-Tu-j_2 with j_2 about 5 units from Tu. Emerson.
2. Ws_3 which was reported in the November 24, 1934, maize letter to be in chromosome 2 on the basis of trisomic ratios is linked closely with lg_1 on the basis of F_2 repulsion data. Rhoades.
3. Gl_8 is in chromosome 5 according to trisomic ratios. F_2 repulsion data indicate that pr and gl_8 are closely linked. Rhoades.

4. $ad_2 = ad_1$, so ad_3 is dropped to ad_2. Rhoades.

5. $bt_4 = bt_1$. Rhoades.

6. The gene for resistance to physiological form 3 of Puccinia sorghi is in the short arm of chromosome 10 according to cytological studies of x-ray induced deficiencies. Trisomic ratios confirm the placings of this gene in chromosome 10. Data from trisomic plants segregating for both R and the rust resistant gene indicate that the two loci are linked. V. H. Rhoades.

7. Eyster's duplicate genes for zigzag stalk are zg_1 and zg_2 and Singh's zg factor in chromosome 6 becomes zg_3.

News items from Morgantown, W. Va.

1. According to genetic tests my gs, mentioned in the December 18, 1933, corn letter, appears to be the same as gs_1. This is a much earlier stock, however. Burnham.

2. Ed. note: Burnham reported several weeks ago that he had some indication that al and B were linked. Unfortunately I have misplaced his letter so I cannot give the data. But if al is in chromosome 2 then the yellow endosperm gene of Perry's (Y_x) should also be in chromosome 2 since it is linked with al.

News items from Pasadena, Calif.

Data on interchanges

Chromosome 1:

Near P 1-2b, 1-9c.
Between P and br 1-3a, 1-5b, 1-9a, 1-10b.
Near br 1-3d, 1-7b, 1-7c, 1-9b, 1-10a.
Between br and bm_2 1-7d. 1-4 and 1-5a about 10 to 20 units from br but order uncertain.

Chromosome 3:

Between a and nana 3-5c, 1-3b and probably 3-9b.
Near na 3-5b.
Nearer ts_4 1-3a, 2-3c, 3-7b, 3-8, 3-9a, 3-10a.

Chromosome 4:

Near su 1-4, 2-4c, 4-6a, 4-6b, 4-6c, 4-8, 4-9a, 4-10a, 4-10b, 4-5d.
Between su and Tu 2-4b.
Near Tu 2-4d.

Chromosome 5:

Between pr and bm_1 2-5b, 4-5d.
Close to bm_1 1-5b, 1-5c.

Chromosome 6:

In Y-P1 neighborhood with much suppression of crossing over 2-6d, 3-6a, 4-6a, 4-6b, 6-8, 6-9b.
Near pigmy 6-10 (probably sm-T-py).

Chromosome 7:

Near ra 1-7b, 2-7b, 2-7c, 3-7a, 3-7b.
Distant from ra 2-7a.

Chromosome 8:

Near jap 8-10c, 3-8a.
15 to 25 units from jap 5-8, 6-8, 8-10a.
Far from jap 3-8b, 4-8, 8-10b, 8-10d.

Chromosome 9:

All tested are in long arm beyond wx.
Less than 10 units from wx 3-9a, 6-9b, 4-9a.
10 to 15 units from wx 6-9a, 1-9a.
About 40 units from wx 1-9b.

Chromosome 10:

Left of R 9-10.
Near g 4-10b, 3-10c.
10 to 20 units beyond g 6-10, 8-10b, 1-10a, 8-10c, 3-10b.
20 to 30 units beyond g 3-10a, 8-10a.

Of the interchanges recorded in my list in Genetics (January, 1935 issue) all but 8 I believe have been obtained in homozygous condition. Anderson.

Preliminary linkage data on a long inversion in chromosome 2, involving most of the chromosome, indicates that there is a map distance from v_4 to the end of the inversion about equal to the map distance from B to v_4. The "left" end of the inversion lies between lg and B about 25 units from lg and 7 from B. Cytological observations show both ends beyond the inversion to be of about equal length. That would suggest that nearly half of the linkage map for chromosome 2 should lie to the right of v_4. In agreement with this, about half of the known interchanges involving chromosome 2 lie beyond v_4. Anderson.

News items from Durham, N. Car.

I now have enough data on the yellow-albescent situation to indicate quite clearly that my hypothesis last spring was correct. I have two factors for yellow endosperm - "Y_x" linked with al (p = .01 - .02) and Y_1 linked with Pl (p = .25 - .30). I have found no evidence of linkage between these two Y's or between Y_x and Pl or py. Selfed plants of the constitution Y_1 y_1 Y_x y_x give F_2 distributions of nine yellow to seven "not yellow" ranging from "lemon" to "white". I selfed some plants from the yellow seeds in such an F_2 and found three groups as follows:

All yellow	3:1	9:7
4	16	14

which came pretty close to the 1:4:4 expected. I grew a few seedlings from some of the three-to-one ears for linkage tests. (F_2 was also segregating for Pl, al, and py). Some showed linkage with Pl, some with al. Only two were segregating for both Pl and al and the distributions for these were as follows:

Y_x				Yx				p-value		
Pl		pl		Pl		pl				
Al	al	Al	al	Al	al	Al	al	Y_x-Pl	Y_x-al	al-Pl
58	0	11	0	2	19	0	7	.42(or .58) ±.046	0+	.404(or .596) ±.045
74	0	22	1	1	24	0	5	.44(or .56) ±.048	.015	. 48(or .52) ±.046
Combined progenies									.016 ±.006	
132	0	33	1	3	43	0	12			

Of course, results like these don't rule Y_x (or al) out of #6 if #6 is very long "genetically" but at least it is at considerable distance from the known factors of that group with which it has been tested. Maybe the trisomics will clear that up. Besides the 9:7, the dihybrid ratios 3:5 and 1:3 have been obtained.

H. S. Perry.

Dwarf$_1$ (d_1) allelomorphs

The following series of allelomorphs exist for the d_1 locus:

d_1 as described by Emerson.
d_1^s semi-dwarf-andromonoecious 50% height of normals.
d_1^m approaching monoecious condition 60-65% height of normal sibs.
D_1 normal height.

The d_1^s and d_1^m allelomorphs are dominant to d_1 and recessive to normal. The three dwarf allelomorphs have different origins:

d_1 from Emerson, d_1^s from Brink (= Brink's d_5) and d_1^m from Beadle.

H. S. Perry.

News items from New Haven, Conn.

1. The brown midrib found in a Country Gentleman inbred (Maize letter December 18, 1933, p. 3) is allelomorphic to bm_1. This is the second occurrence of bm_1 at New Haven.

2. The brown midrib found in a Sweepstakes inbred (Maize letter November 24, 1934, p. 8) is bm_2 or an allelomorph.

3. The fine stripe reported in a Sweepstakes inbred (Maize letter November 24, 1934, p. 8) has proved to be allelomorphic to f_1.

News items from Columbia, Mo.

Mutant seed characters of possible value from x-ray experiments:

Mutant	Description	Linkage Indications	Notes
$Scarred_a$	Seed small and distinctly scarred. Separation clear. Only best sc seeds give usable plants.	Close to Y.	
$Scarred_b$	1/8 to 1/2 volume, usually scarred. About 3/4 are germless.	Possibly with Y.	
$Scarred_c$	1/8 to 3/4 volume. Have fair embryos, and larger seeds give fairly good plants.	Possibly with Pr.	
Etched	Seed full size, etched pattern distinct, separation clear, and viability good. Somewhat resembles scarred but can be separated from it.	Possibly with with Pr.	All et seeds give virescent seedlings, turning fine striped then green. (Viability good.)

Mutant	Description	Linkage Indications	Notes
Rudimentary$_1$	2/3 height and width, 1/5 thickness, germless. Can be separated for aleurone color, wx, etc.	With Pr.	
Tiny	Very small seed but germinates and produces small seedlings.	None.	Possible dominant effect in partial dwarfing of heterozygous plants.
Thin	Normal height and width but less than 1/3 thickness to empty. Some have germs and a few might grow.	With CWx	
Miniature$_3$	Reduces size of seed, especially thickness. Possibly overlaps normal.	Probably with Wx.	Partly eliminated in pollen, though pollen appears normal.
Miniature$_9$	3/4 to full height and width, 1/2 thickness. May overlap normal.	With Pr.	
Miniature$_{18}$	1/2 to 2/3 height and width and 1/3 to 1/2 thickness of normal. Clear separation. Low ratio. Good viability.	With Pr.	
Germless$_a$	Full size endosperm, typical germless.	Possibly with Y.	Not induced.

Stadler.

A simplification of chromosome-mapping technic is possible by the use of haplo-viable deficiencies transmitted through female and not through male germ cells. These are fairly common among the variants induced by x-ray treatment. The most useful ones are those located in the middle region of the chromosome. This technic may be illustrated by an example using Df 5_1 (described in abstract in Records Genetics Society 3: 56-57). This deficiency includes the locus of V_3 and is located on the longer arm of chromosome 5 near the spindle node. It is transmitted with little loss through female gametes but deficient pollen is defective and does not function.

In using the deficiency for chromosome mapping it is used with a dominant marker on the same chromosome. We use Pr, since the mutants to be treated are induced in a pr stock. (With mutants not known to be pr the same method could be used with Ch as the dominant marker, since all new mutants will presumably be ch.

The new mutant x is crossed on the Df 5 Pr stock and a Df 5 plant of the F_1 (recognized by its partially defective pollen) is crossed on the x stock. The progeny of this cross shows the location of the new mutant with reference to the loci of V_3 and Pr, and since it is virtually a backcross test a relatively small progeny is sufficient. Since the Df pollen is eliminated, the dominants Pr and X appear only in gametes resulting from crossing over between their loci and that of the Df. Thus the regional location of the new locus will be indicated in three point order in the second generation from the original cross, without the necessity of producing the double recessive in a large F_2 and a third generation for the backcross ratio.

If Df 5_1 is representative in its effect on crossing over, these crosses will not serve to determine the normal crossover frequency. Df 5_1 greatly reduces crossing over in the region including it (Pr-V_3 reduced from 26-33% to 5-12%; V_3 - Bm reduced from 4-6% to 1%). Cytological observations indicate that this effect may be general for internal deficiencies. This means that backcrosses of non-deficient individuals will have to be used for final mapping, but the non-deficient sibs of the same crosses may be used for this. The reduction of crossing over in the deficient plants will be an advantage in reducing the genetic length of the chromosome so as to permit the detection of linkage over longer actual distances.

It might be worth while to construct haplo-viable Df stocks deliberately for this purpose, particularly in the case of the longer chromosomes. Probably one well placed Df would do for each chromosome. Preferably the Df should include a locus somewhere in the middle region, and the dominant marker used should be far enough away for fairly frequent crossing over. The dominant should be one not likely to occur in the mutant stocks, as P, B, Rg, Ch, Pl, etc. The recessive should be a seedling character so that a large number of plants may be examined in looking for the induced deficiencies. Such deficiencies may be obtained by irradiating the pollen of the dominant stock, pollinating on the recessive, growing to maturity the F_1 plants showing the recessive character, and pollinating all which by their plant development and pollen development seem likely to be haplo-viable deficiencies. The best pollen to use on these plants will be pollen carrying two (or more) recessive markers widely separated in the chromosome. Then, when the Df plants are pollinated by the new mutant, the Df progeny may be used as outlined above and a few non-deficient sibs may be selfed to provide F_2 material with widely separated markers, for accurate mapping if the Df test indicates linkage. Thus, for chromosome 3, a suitable technic would be as follows: Treat Rg and pollinate on lg_2, save

only $\underline{lg}_2$ seedlings, and pollinate suitable ones by $\underline{a}\ \underline{d}_1$. The $\underline{Rg}$ $(lg_2)^{-}/\underline{a}\ \underline{d}_1$ plants thus secured are suitable for pollination by the new mutants, and the $\underline{Df}$ stock is maintained by pollinating in each generation by $\underline{a}\ \underline{d}_1$ and using only the $\underline{Rg}\ \underline{Df}$ plants of the progeny.

If any corn breeder not having x-ray equipment available wishes to make up such a stock for his chromosome, we should be glad to make the necessary treatments and pollinations for him here next season, using the stocks designated by him for the purpose.

Stadler.

News items from Washington, D. C.

From a perennial teosinte-corn hybrid has been isolated a cornlike strain with 20 chromosomes in which chromosome IX has a terminal knob on the short arm and a large internal knob on the long arm. Measurements show the terminal knob to be approximately 0.33 of the whole length of the chromosome from the spindle fibre attachment, the internal knob approximately 0.52 of the whole length of the chromosome from the spindle fibre attachment and approximately 0.15 from the end of the long arm.

The terminal and internal knobs are frequently stuck together so that at first it gave the impression that the loop was due to the pairing of a normal IX with a IX that had an inversion.

Seed of this strain is available.

A. E. Longley.

News items from Bucknell University

1. A new fine-striped* chlorophyll pattern in Chromosome 10 as indicated by its linkage with the R aleurone color gene.

	R	r	R St	R st	r St	r st
Backcrosses	1206	1213	822	121	203	776

Crossing over ca 17%.

*Ed. note: This gene is f_3.

2. Bn_1 in chromosome 5.

A) Field grown	Bn	bn	Approx. Ratio
Group 1	2495	763	3.27 : 1
2	633	101	6.27 : 1
3	1055	64	16.48 : 1
4	292	3	97:33 : 1

B) Greenhouse grown

	Bm	bm	Approx. Ratio
Group 1	4456	1510	2.95 : 1
2	3551	1123	3.16 : 1
3	1616	111	14.56 : 1
4	745	10	74.50 : 1

C) Relation between Pr and bm

	Pr Bm	Pr bm	pr Bm	pr bm
F_2 Field grown	1870	341	298	486
Greenhouse	941	124	167	234
Backcrosses-Field	503	2169	2048	387
Greenhouse	2551	765	767	2306
"	441	198	199	408

D) Relation between Bm and Tn

	Bm Tn	Bm tn	bm Tn	bm tn
F_2 Field grown	814	35	57	135
	699	7	6	134
Greenhouse	3894	58	56	1266
Backcrosses-Coupling	806	12	18	785
Repulsion	95	48	52	0

E) Relation between Pr and Tn

	Pr Tn	Pr tn	pr Tn	pr tn
Backcrosses	452	197	190	398

F) Cross involving Pr, Bm, and Tn

	A B	A B	A b	a B	a b
Backcrosses	Bm Tn	116	2	1	102
	Pr Tn	32	88	85	16
	Pr Bm	32	88	86	15

G) Relation between Bm and Oy

	Bm Oy	Bm oy	bm Oy	bm oy
F_2	458	154	126	29

H) Relation between Pr and Oy

	Pr Oy	Pr oy	pr Oy	pr oy
F_2	348	105	112	29

I) Relation between Pr and Vp_2

	Pr Vp	Pr vp	pr Vp	pr vp
F_2 repulsion	1474	616	690	21
	284	129	116	5
	94	47	39	5
	103	49	46	2

J) Relation between Pr and reduced kernel (re).
Re and Vp_2 are extremely closely linked.
In above data under Hall vp kernels were also reduced. The following data involve re but not vp.

	Pr Re	Pr re	pr Re	pr re
F_2	241	129	130	2

K) Relation between Bm and an ovule lethal or rather embryo sac lethal.*

Bm Ol	Bm ol	bm Ol	bm ol
127	6	(6)	(39)

*Ed. Note: Symbol should be lo_2.

L) Relation between Pr and stiff leaved plant (sf).

	Pr Sf	Pr sf	pr Sf	pr sf
F_2 repulsion	235	91	109	9
coupling	274	87	79	48

M) Relation between Bm and Sf

Pr Sf	Pr sf	pr Sf	pr sf
45	21	24	1

N) Relation between Pr and a yellow green (yg)

	Pr Yg	Pr yg	pr Yg	pr yg
Backcross	59	81	96	65

3. Sugary endosperm. The sugary endosperm which has been used in experimental work since the beginning of maize genetics is designated as su_1.

A) Interrelation between $sugary_1$ and $sugary_2$

su_1 x su_2 - All starchy

	Su_2	su_2
su_2 x starchy - starchy in F_1 - F_2	4407	1318
Backcrosses	1884	1594

	Su_1 Su_2	Su_1 su_2	su_1 Su_2 su_1 su_2
F_2 from su_1 x su_2	9493	2991	4069

B) Relation between su_2 and Y.

	Y Su_2	Y su_2	y Su_2	y su_2
F_2	1930	394	393	340
Backcrosses	1065	492	577	895

C) $Sugary_3$ in chromosome 9

a) Relation between $sugary_3$ and shrunken endosperm

	Su_3 Sh	Su_3 sh	su_3 Sh	su_3 sh
17050-4 (X)	267	18	13	113
-7 (X)	261	71	54	90
-5 (X)	114	13	15	19

b) Relation between su_3 and pr_2

	Pr Su	Pr su	pr Su	pr su
17011-4 (X)	184	15	17	55*
-1 (X)	170	9	7	45*
17012-1 (X)	157	71	78	4**

* coupling
** repulsion

4. A new gene for red or rather for purple aleurone. This gene is called Pr_2 and belongs in chromosome 9 as indicated by linkage relations between Pr_2 and wx and also with su_3.

	Wx Pr	Wx pr	wx Pr	wx pr
17078-6 (X)	207	58	65	43
-1 (X)	170	73	63	30

5. New genes in chromosome 9.

A) Pr_2 and su_3 have already been mentioned.

B) Defective kernel

Da_1 De	Da_1 de	da_1 De	da_1 de
168	13	(13	(54

C) Pale green seedling and plant

Sh Pg	Sh pg	sh Pg	sh pg
127	42	33*	17*
194	72	46*	21*
34	14	9*	2*
96	43	40*	18*

*Deficiencies due poor germination of sh kernels.

Wx Pg	Wx pg	wx Pg	wx pg
163	82	87	3**
96	40	41	22*
112	68	101	1**

* coupling
** repulsion

C Pg	C pg	c Pg	c pg
92	38	44	23

D) Duplicate genes for zigzag culm showing linkage with genes in chromosome 9.

Ms_2 Zg	Ms_2 zg	ms_2 Zg	ms_2 zg
210	10	97	16
224	9	66	15

E) New chlorophyll pattern

Wx St*	Wx st	wx St	wx st
237	8	31	59

*Ed. Note: St has been used for sticky chromosomes. Some other symbol is necessary.

F) Lethal male gametophyte (Gm_2?)*

$$\frac{Sh\ wx}{sh\ wx} \times \frac{Sh\ wx\ Gm}{sh\ Wx\ gm}$$

Wx Sh	Wx sh	wx Sh	wx sh
250	195	1895	200

*Ed. Note: Gm is used for germless seed. Another symbol is necessary.

sh --- 17 92 --- Wx --- 17.52 --- gm.

G) A second male gametophytic lethal is almost completely linked with the Wx wx gene pair. Call this gm_3 ?

6. Reduced kernel linked with aleurone color, but not with the gene C, as indicated by tests with a number of genes in chromosome 9.

Colored		Colorless	
Re	re	Re	re
318	26	34	77
280	32	179	95
334	124	121	33
256	37	46	37
352	89	138	45

7. Pale green seedling linked with aleurone color but not with the C c gene pair.

8. Defective endosperm due to a gene in chromosome 10 as indicated by linkage with striped chlorophyll pattern described in 1 in this news letter.

De St*	De st	de St	de st
235	15	83	

* st = f_3.

9. Vivipary$_4$ in chromosome 9.

Sh Vp	Sh vp	sh Vp	sh vp
273	81	63	36
175	47	40	123
75	76	12	57

10. Reduced kernel$_3$ in chromosome 9.

A B	A B	A b	a B	a b
Sh Re	185	55	68	30
	244	63	69	44
	196	69	62	43
	245	58	69	45
	216	83	71	32
	279	108	98	58
	120	71	29	2--?

A B	A B	A b	a B	a b
Wx Re	196	60	57	25
	197	45	46	39
	241	69	72	38
	229	76	82	30

11. Linkage between speckled aleurone and lethal yellow seedling. Linkage group not known.

Self colored aleurone		Speckled aleurone	
Green	Yellow	Green	Yellow
89	33	43	7
96	8	7	22

Extensive data on cards but not summarized.

12. New yellow lethal in chromosome 9

133 C L - 32 C l - 30 c L - 25 c l.

13. Yellow green linked with aleurone color, specific gene not known.

Colored aleurone		Colorless aleurone	
Green	Yellow green	Green	Yellow green
374	88	64	35

14. Yellow green linked with sugary endosperm$_1$. Yg plants viable and grow to maturity.

15. The gene Le modifies endosperm color from lemon yellow to orange. Y Le gives orange yellow, Y le gives lemon yellow endosperm color.
A gene for yellow lethal seedling (l) is almost completely linked with the gene for le. Extensive data on cards but not summarized at present.

Sample - 233 Le L - 16 Le l - 1 le L - 78 le l.

16. A gene for purple (A-type) seedling in chromosome 9 closely linked with yg$_2$.

17. A gene for reduced kernel closely linked with a gene for semi-dwarf, stiff leaved, finely but distinctly lined (chlorophyll pattern) plant.

18. A new gene for constricted ear. Locus not known.

19. Duplicate genes for aurea chlorophyll. Extensive data on cards but not summarized.

20. Conspicuous seedling fine chlorophyll stripe closely linked with one of the genes for striped auricle (sa). Linkage group not known.

21. co and ad are alleles.

22. Male sterile in chromosome 5 almost completely linked with the gene for stiff leaves (sf). Although thousands of plants having stiff leaves have been examined only less than a half dozen such plants with fertile tassels have ever been observed.

Eyster.

Mr. Burr Robinson, graduate of the Connecticut Agricultural College and for several years assistant in genetics at the Connecticut Agricultural Experiment Station, has been appointed to the Fellowship in Genetics in the Bucknell Laboratory, established by the W. Atlee Burpee Seed Company.

A limited number of copies of a monograph, "GENETICS OF ZEA MAYS", reprinted from Bibliographia Genetica, Vol. XI, are available and will be sent postpaid for $1.50. Orders should be sent to Dr. William H. Eyster, Botanical Laboratory, Bucknell University, Lewisburg, Pa.

Eyster.

Paraffin Method for Root-Tip Chromosome Counts

L. F. Randolph

The reagents employed and the sequence of transfers from fixation to paraffin-ribbon mounts are as follows:

1. Fix roots 12 to 24 hours in "Craf" (Chromo-acetic-formalin):
   Solution A, Chromic 1 gr., Acetic 7 cc., Water 92 cc.
   Solution B, Formalin 30 cc., Water 70 cc.
   Mix equal parts A and B just before using.
   This fluid was developed primarily for making chromosome counts in the root-tips of maize, but it has proved to be very useful for similar studies in many other plants.

2. Transfer roots directly from Craf to 75% alcohol, changing several times at half-hour intervals to remove most of the fixing fluid; then to 85% alcohol.

3. From 85% alcohol to normal butyl alcohol as follows:

   (1) H_2O 15 cc., 95% ethyl 50 cc., butyl 35 cc.
   (2) " 5 cc., " " 45 cc., " 55 cc.
   (3) Absolute ethyl 25 cc., butyl 75 cc.
   (4) Normal butyl, 3 or 4 changes.

   Leave roots at least an hour in each solution, 2-3 hours in pure butyl.

4. Infiltrate gradually with paraffin: Add melted paraffin (melting point 54-55° C.) in an amount equal to about one-third the volume of the butyl alcohol covering the roots. Add the paraffin slowly so it will solidify on top of the butyl alcohol. Place the receptacle (preferably a 30 or 50 cc. pyrex beaker) containing the roots and butyl-paraffin mixture in a paraffin oven at 56° C. Leave over night. As the paraffin melts it passes slowly to the bottom of the beaker and gradually infiltrates the roots. The next day pour off the butyl-paraffin mixture and add pure liquid paraffin. Repeat 3 or 4 times at hourly intervals.

5. Embed, cooling the paraffin rapidly in ice water.

6. Prepare cross-sections 10 to 15 microns in thickness. Spread ribbons on slides and dry for several hours at about 40° C.

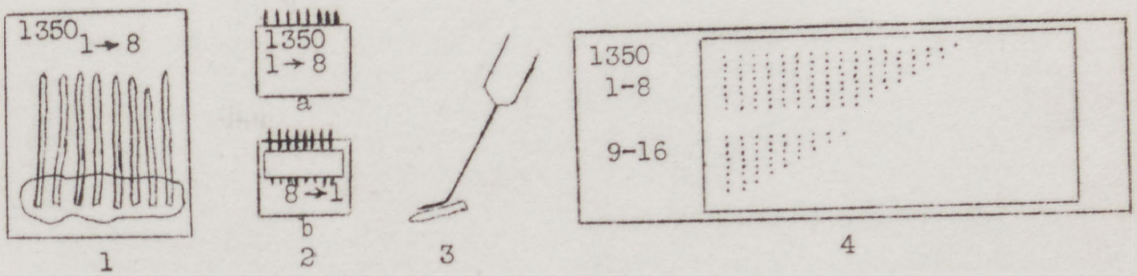
Card Mounts for Root-Tips in the Paraffin Method.

L. F. Randolph

To facilitate the handling of root-tips in the paraffin method they may be mounted on cards in the following manner.

1. Prepare small pieces of heavy paper approximately 2 cm. x 2.5 cm. in size (the heaviest grade of Y and E filing cards is suitable). Smear the base of a card with DuPont household cement, or LePage's waterproofing cement. Add roots and cover with more cement, leaving at least .5 cm. of the tip of the root free (fig. 1). Invert at once in the fixing fluid, keeping the cards separated until the cement has partially hardened.

2. After fixation and transfer to 75% alcohol, snip off the tips of the roots from the original card in a petri dish containing a small amount of alcohol. Prepare a second smaller card, approximately 7 x 12 ~~cm.~~ in size. Label one side (Fig. 2a), and coat the other side with a thin layer of mucilage, using a clear, amber-colored grade of Carter's or Stafford's mucilage evaporated to the consistency of heavy syrup. Rapidly transfer the roots one by one from the petri dish to blotting paper for removal of the excess alcohol, and then to the second card. Add more mucilage and a thin strip of paper to help hold the roots in place (Fig. 2b). Immerse the card with roots attached at once, right side up, in 85% alcohol. The mucilage may be conveniently applied with a No. 2 or



1 2 3 4

No. 3 camel-hair brush. For transferring the roots quickly from the blotting paper to the card a bent dissecting needle applied to the moist surface of the root is very effective (Fig. 3). The final orientation of the roots on the card may be completed after transfer to 85% alcohol. The root-tips should project approximately 2 mm. beyond the edge of the card, and care must be taken that the tips are kept free of mucilage since it causes trouble in sectioning.

3. After the mucilage has hardened the card mounts are placed in a 30 cc. or 50 cc. pyrex beaker and dehydration and infiltration are completed in the usual manner. The mounts should be embedded with the labelled side down so that the mounts may be identified readily. Paraffin ribbons from two or more card mounts may be placed on the same slide (Fig. 4).

Crystal Violet Staining Procedure for Root-Tip Chromosomes.

L. F. Randolph

1. Place slides in xylol to remove the paraffin. Flush with fresh xylol, then with absolute alcohol. Pass the slides successively through 95%, 60% and 30% alcohol to water, 3-5 minutes for each step.

2. 1% potassium permangenate, 2-3 minutes. Rinse in tap water.

3. 5% oxalic acid, until the sections are bleached - usually 1-3 minutes. Prolonged treatment with oxalic acid sometimes causes the sections to come off the slide. Wash in tap water 15 minutes. The bleaching process in permangenate and oxalic is not always necessary, but it usually adds contrast.

4. Mordant in 1% chromic, 20 minutes. Rinse in tap water and then in 2 or 3 changes of distilled water.

5. 1% aqueous solution of crystal violet, 4 hours. It is often desirable to vary the staining period. If the stain comes out too rapidly in the alcohols and clove oil, leave the slides in the stain longer. If destaining is prolonged, shorten the period. Rinse in tap water.

6. Treat with iodine-potassium iodide (iodine 1 gm., potassium iodide 1 gm., 80% alcohol 100 cc.) until the color of the sections changes from blue to brown, usually 1-2 minutes.

7. Rinse in 95% alcohol and pass through 3 changes of absolute alcohol to clove oil. Differentiate in the alcohols and clove oil, ordinarily 1-3 minutes. Watch the process in the final stages under the microscope. The metaphase chromosome groups under a 16 mm. objective should stand out sharply against a practically colorless background of cytoplasm.

8. Pass through several changes of xylol to remove all of the clove oil. Mount in thin xylol-balsam. After the cover glass is in place invert the slide on paper toweling and apply mild pressure to force the excess balsam from under the cover glass. Add a few drops of xylol to the edges of the slide, cover with another paper towel and a piece of heavy glass, or other suitable weight. As soon as the slides are dry they may be examined. This method of mounting removes all excess balsam and brings the cover in close contact with the material, so that high-power objectives may be used with greater safety.

Publication of new linkage data

It has become increasingly difficult to secure publication of papers presenting linkage data for new genes in maize. Some scientific journals refuse to accept this type of work for publication. Yet it is extremely important that a short description of new characters and a summary of the linkage data appear in some recognized Journal so that this information will be made generally available.

In conversations with Richey, Jenkins and Brink at the recent Pittsburgh meetings the following solution was suggested: "That there be published annually a paper under the general heading 'New Linkages in Maize', or some similar title, which would present short descriptions of new characters with the linkage data given in summary form. This material would be contributed by the various workers. The name and address of the contributor would appear either before or after each linkage he reported so that he would get the credit which rightfully belongs to him."

The above suggestion will, of course, have to be developed in greater detail but we believe it should receive careful consideration from you because it offers a remedy to the rather serious problem of securing publication for new linkages.

The amount of space devoted to each character will have to be limited to not more than one printed page and preferably less. This allotment should prove sufficient, although some leeway would, of course, be permitted. This proposed publication is not, in any sense, to be considered as supplanting the maize letters because as we have so often reiterated, the appearance of information in the maize letters does not constitute publication.

If this proposed annual paper of new linkaged will not be acceptable for publication in one of the Journals, we suggest that space be purchased at so much per page. For the next four years at least there will be funds available from the grant made by the Rockefeller Foundation to the Maize Genetics Cooperation which can be used to pay for the publishing of this paper. One attractive feature of purchasing space is that we could secure immediate publication. The contributions from the various investigators would be edited and compiled by the Secretary of the Maize Genetics Cooperation.

Give us your opinion of this idea and, more important, would you be willing to take part in such an enterprise ?

Below is a copy of a letter which was received from Jones in response to an enquiry as to what he thought of the idea from his point of view as Editor of GENETICS:

"Dear Dr. Rhoades:

I am much interested in your suggestion as to a way of publishing linkages. I should like very much to try something of this kind and see no reason why it would not be acceptable in GENETICS. I agree with you that the information should be published but in the past, authors have usually expanded each individual

case of linkage into a 5 or 6 page paper or more, and facilities have not permitted the publication of this much material. If each item could be condensed into a page or less, I think the arrangement would be advantageous for all concerned. Some provision would have to be made for references so that each separate contribution should have a main heading together with the author's name and address.

The principal difficulty that I see will be to get someone to summarize this material and get it in shape for publication. If you are willing to do this or anyone else can be persuaded to do it, we shall be very glad to do our part.

(Signed) D. F. Jones."

Inasmuch as I am severing my connections with Cornell to take a position with the U. S. Department of Agriculture at Ames, Iowa, I necessarily am relinquishing my duties as Secretary of the Maize Genetics Cooperation. Until, however, Dr. Emerson appoints my successor I shall be willing to continue to act as Secretary so that there will be no lapse in the functions performed by this office. Until March 20th I can be reached here at Ithaca and after March 20th at Ames, Iowa, c/o Department of Farm Crops, Iowa State College.

I wish to state that I have really enjoyed my work with the Maize Genetics Cooperation and I hope that my successor will receive the same fine cooperation from the maize geneticists which has made possible this unique series of corn letters.

Sincerely yours,

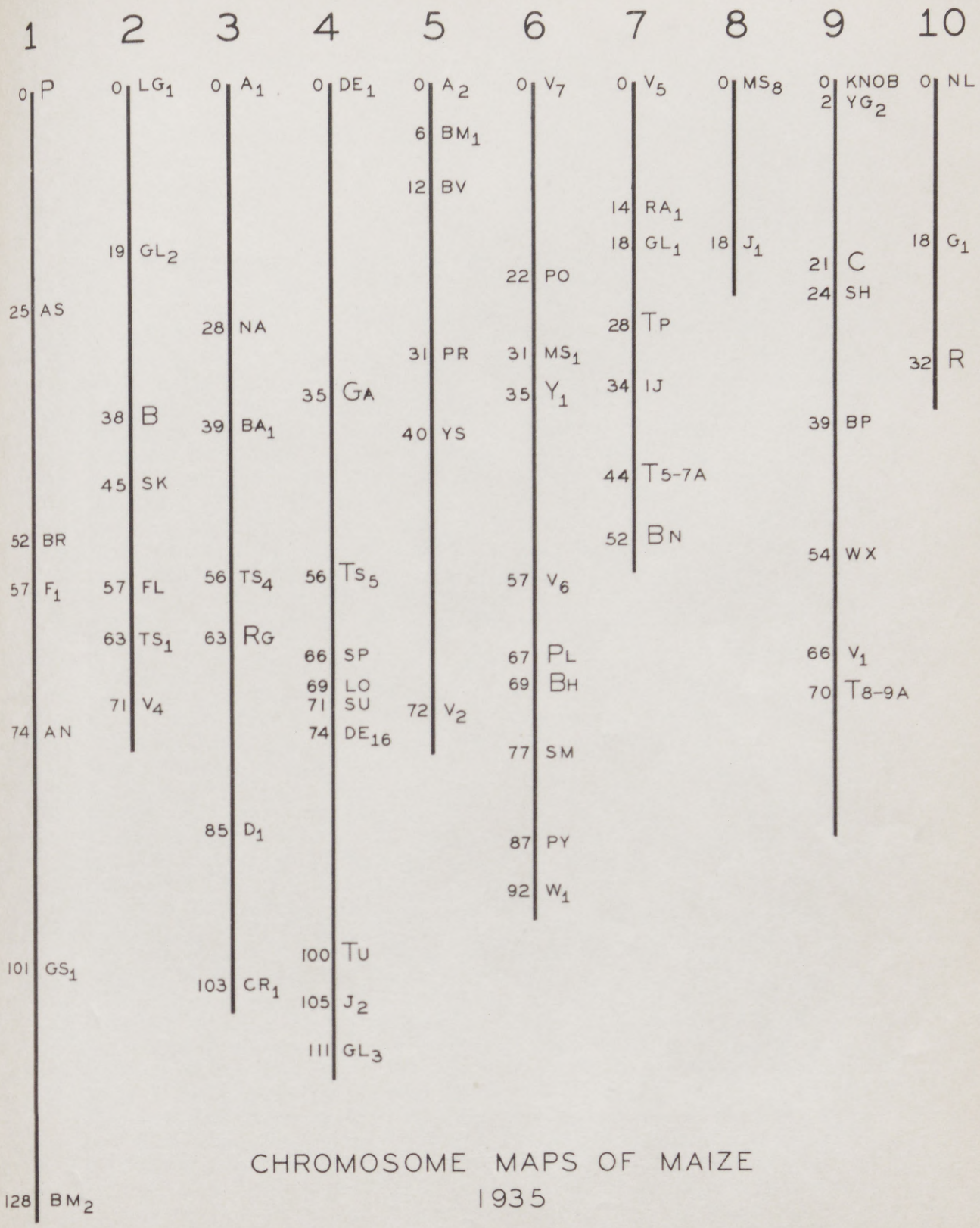
M. M. Rhoades

MMR:B

M. M. Rhoades

The enclosed maps of the linkage groups were made from the data which Emerson has assembled for the forthcoming paper on linkages in maize by Emerson, Fraser and Beadle. Only those loci whose position is known with reasonable accuracy are listed. We are indebted to the Division of Cereal Crops and Diseases, U. S. Department of Agriculture, for furnishing the copies of these maps.

M.M.R.



CHROMOSOME MAPS OF MAIZE

1935

Exhibit "B"

Put after Vol. 9 before " 10.

MAIZE GENETICS COÖPERATION
DEPARTMENT OF PLANT BREEDING
CORNELL UNIVERSITY
ITHACA, NEW YORK

November 30, 1935

To Maize Geneticists:

I

The summary of linkage in maize is finally off the press as Cornell Agricultural Experiment Station Memoir 180, and a copy has been mailed to each of you. The authors realize that this summary is already a year or two out of date, but hope that it will serve a useful purpose as a base of reference for future linkage studies. It will, of course, have to be revised from time to time, but probably a general revision should not be attempted for some years. Your secretary believes that, for the present at least, it will be better for those of you who are interested in a particular linkage group to publish a revision of that group when you have data sufficient to straighten out any of the confusing and even contradictory situations apparent in many of the groups as presented in the summary. When one has evidence sufficient for a thorogoing revision of any one of the ten groups, it should not be difficult to find a place for publication of a concise paper setting forth the revision.

Pending the time when any of us are ready to publish such revision, the data obtained should be made available to others. Moreover, most workers find a miscellaneous lot of linkages the data on which should be made known to the rest of us. In the past many such records have been sent to you in mimeographed form, but always with the caution that such distribution does not constitute publication and that no one other than the one who contributed the data has any right to use them without permission,in a published paper. This is not an ideal arrangement. The data should be published at once. But it is almost impossible to find a journal that will accept a paper presenting data say on a single linkage.

It has been proposed that those of you who have linkage data worth publishing but not of sufficient importance to warrant a separate paper send to the secretary of Maize Genetics Cooperation brief, concisely worded accounts embodying the data and that these short papers be published together under some general heading, but each to be signed by the responsible author. I have been informed that the outgoing editor in chief of Genetics has approved this suggestion, but it has not been presented to the incoming editor, Dr. Dunn. If the publication of such a collection of brief papers is paid for from sources other than the publishers of Genetics, very prompt publication can be assured. It would seem that the grant of funds made by the Rockefeller Foundation for the support of Maize Genetics Cooperation might be used legitimately for this purpose. Before presenting this proposal to the Rockefeller Foundation for

decision, I desire an expression of opinion, favorable or unfavorable, from as many of you as possible. I shall also want an indication of how many of you may desire to have papers included in such a collection to be published late this winter or early in the spring.

II

Reports have been received from a few of you who grew inbred strains last summer to determine relative resistance to smut and other diseases, general adaptability, etc. I trust that the others who received seed of these strains will report soon so that all reports can be tabulated for the next news letter. It is already apparent that no one or two of these strains will be useful in all regions of this country. Since the strains tested the past summer came from only two sources, Dr. Hayes and Dr. Wiggans, it seems probable that others of you may have or know of inbred lines better adapted to some regions than any of the strains so far tested. If you will indicate this to me, a further test can doubtless be arranged next season.

Altho the inbred strain test was started with the hope of finding one or more strains widely resistant to smut, which is a serious drawback to many of the genetic stocks grown by some of us and particularly serious in case of plants injured in collecting sporocyte material for cytological study, the crossing of good inbred strains with genetic stocks may prove very useful in other ways. If one desires to make an accurate comparison of segregates in any culture involving even so few as two allelomorphic characters, it is necessary to use relatively large numbers of individuals to make sure that the nine chromosome pairs other than the one directly involved in the comparison are, on the average, the same in both segregates. When, by the nature of the comparison, one is limited to a few individuals, as might well be the case in certain histological, physiological, or chemical investigations, it becomes essential to employ material with as uniform as possible a background of genes other than those involved in the study. Such material can probably best be obtained by repeated backcrosses of the recessive segregates to the same inbred line. Backcrossing separately to two inbred lines makes it possible later to study the segregates in vigorous material by intercrossing two such backcrossed progenies. In line with this purpose, crosses were made last summer of six dwarf and semidwarf types with two of the inbred strains which did well at Ithaca. This was done to get material for Mrs. Abbe's (Minnesota) histological and developmental study of these types. In so far as possible, other undesired genes linked with the pair to be studied were involved in the crosses. When in progressive backcrosses these unwanted genes are lost, one can be reasonably sure that a considerable part of the chromosomes carrying the genes to be studied, as well as the other nine pairs, are relatively uniform genetically for both normal and dwarf segregates. Even one or two backcrossings should afford material that is much more nearly uniform than are most segregating genetic stocks now in use.

III

Hand pollinations of the cooperative material last summer were for the most part highly successful. We shall be able to include a list of these stocks in the next news letter.

A list and seed of new stocks which any of you may have and which have not previously been sent to the secretary are herewith called for. The list should be ready for the next news letter and the seed should be sent as soon as convenient.

IV

This is also a call for items of interest to be included in the next news letter. Please include new genes, indications of linkage of new or well known genes, etc. Linkage data might well be included unless you intend to submit them later for independent publication or for collective publication as proposed in this letter.

V

- Summary -

1. Please report promptly on behavior of inbred strains if you grew them and have not yet reported (See II above)
2. Send list and seed of new stocks (III)
3. News items are now due (IV)
4. Indicate (a) whether you do or do not favor the proposed collective publication of short signed articles on linkage in maize, (b) whether you will probably be able to submit such articles by late winter or early spring, (c) deadline date favored for reception of such articles.
5. All these items (1-4 above) should reach me by December 20, 1935, so that the next news letter can be sent out early in January.

(Signed) R. A. Emerson
Secretary "pro tem"